Camp Lick Project

Soil Report

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for:

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Introduction

The intent of this specialist report is to disclose the effects of the proposed actions on soils, so these effects can be considered while making the decision.

Regulatory Framework

The Malheur National Forest Land and Resource Management Plan (Malheur Forest Plan) provides standards and guidelines for soil that meet all legal and regulatory requirements, including:

- Standards and Guidelines – Forest Plan Forest-wide standards 56, 101, 103, 104, and 125-129 pertain to soil. Supplemental management direction includes Forest Service Manual R6 Supplement No. 2500.98-1.
- Forest-wide standard 126 stipulates that detrimental conditions, including roads, shall not exceed 20 percent. Since an average of 3 percent of the total area of proposed units is in roads, the limit for detrimental conditions, excluding roads, is 17 percent.

Regarding federal laws directly pertaining to soil, Forest Service Manual R6 Supplement No. 2500.98-1, section 2520.2 says objectives of soil management are "To meet direction in the National Forest Management Act of 1976 and other legal mandates. To manage National Forest System lands ... without permanent impairment of land productivity and to maintain ... soil ... quality.... Soil quality is maintained when soil compaction, displacement, puddling, burning, erosion, loss of organic matter ... are maintained within defined standards and guidelines." Therefore, if an action maintains detrimental conditions within the standards of the Malheur Forest Plan, legal and regulatory requirements for soil protection would be met.

Resource Elements, Indicators and Measures

Issue Statements

- Proposed activities that may cause direct and indirect physical disturbance have the potential to unacceptably degrade soil quality.
- Proposed activities that may cause direct and indirect physical disturbance have the potential to cause soil erosion and thus may degrade water quality or permanently degrade soil productivity.
- Proposed activities that may cause removal of organic matter from sites have the potential to unacceptably degrade soil productivity.

Table 1. Resource elements, indicators and measures for assessing effects

Resource element	Resource indicator	Measure	Source
Soil quality	Detrimental impacts (compaction, displacement, detrimental burning, puddling)	Number of units that do not meet the standard	MNF Forest-Wide Standard 126
Soil erosion: Water quality	Adverse effects to water quality	Sediment that reaches streams, from soil in units	National best management practices for water quality management on National Forest System lands, Vol. 1, p. 131

Resource element	Resource indicator	Measure	Source
Soil erosion: Soil productivity	Permanent impairment of soil productivity	Accelerated erosion on highly erodible soil and after activities	FSM R6 Supplement No. 2500.98-1. MNF Forest-Wide Standards 103 & 127
Organic matter & nutrients	Amount (pounds per acre) of organic matter and nutrients	Amount of organic matter and nutrients, compared to amounts before fire suppression	Public interest

Soil Quality

Affected Environment

Methodology

Soil Types

The best source of information about the location of soil types is the Terrestrial Ecologic Unit Inventory (TEUI). The TEUI is available as a digital map layer and associated database. Maps of ash coverage, geology, mollic soils, and slope can be found in the project record.

Detrimental Impacts

Technicians who were trained by a soil scientist did soil "assessments" in all stands that met the following criteria: 1) not too steep; 2) outside riparian habitat conservation areas (RHCAs), old growth, and roadless areas; 3) larger than 19 acres; 4) appeared, from satellite photos, that medium amounts of wood volume could be removed; and 5) existing impacts seemed to be visible on satellite photos. Assessments were done in the summer of 2014 and 2015. For the assessments, technicians collected semi-quantitative information about impacts from past and ongoing activities, and inspected to see if special design elements were needed to protect soil. The soil assessments reveal all impacts from past and ongoing activities listed in the Camp Lick EA, Appendix E – Past, Present, and Reasonably Foreseeable Future Actions, including timber harvest, roads, fuel treatments, fire suppression, livestock grazing, off-highway vehicle use, firewood cutting, and other past and ongoing activities. Sixty-one percent of the proposed ground-based commercial harvest acres are in units which were either 1) assessed by technicians or, 2) had no existing impacts visible on satellite photos. In addition, 15 percent of the acres are in units where no logging has taken place in the last 40 years; these areas are likely have low existing impacts. Furthermore, 22 percent of the acres are in units where satellite photos appeared to show that a relatively light volume of wood would be removed, so these units would be expected to experience only small increases in detrimental impacts. Thus it is likely that all units that could be cumulatively impacted more than 17 percent by logging were sampled during the soil assessments.

Units 148, 242, 264, and 348 are unusually heterogeneous, in terms of existing detrimental impacts. In these units, certain stands have very different existing detrimental impacts from one another. For instance, different stands in unit 148 have existing detrimental impacts that range from 4 to 12 percent. Since these units were formed by joining disparate vegetation stands together, it would be misleading to treat all parts of these units as if existing detrimental impacts are uniform over the whole unit. Thus units 148, 242, 264, and 348 were divided into subunits for purposes of soil analysis and soil design criteria. Location of the subunits are available in the project record.

Existing Condition – Soil Quality

Soil Types

Soil types vary in their response to logging, based on such factors as the presence of a volcanic ash cap, geology, soil depth, and rockiness.

The presence of a volcanic ash cap causes important differences in soils. Most soils in the Blue Mountains are influenced by ash, but soils with a distinct cap of ash differ from soils where ash has been partially eroded away or mixed with the residual soil (called here "mixed ash"), because typically ash cap soils have more total ash than mixed ash soils. Ash cap soils typically supply more water to plants, because: 1) ash holds relatively large amount of water, 2) ash cap soils are typically deeper, and 3) ash caps have less coarse fragments in the top soil than mixed ash soils. Thus ash cap soils are typically more productive than mixed ash. Ash cap soils typically support mixed conifers including true fir, whereas mixed ash soil typically does not support true fir. In addition, ash cap soil has a high porosity and little clay, so it has a high infiltration rate. An ash cap is more easily displaced than mixed ash soil. Ash cap soils tend to occur on north and east facing slopes, although there are significantly less ash cap soils in the lower reaches of Camp Creek and Lick Creek, and surrounding Whiskey and Cottonwood creeks.

Rock types in this planning area cause some variation in soils. About 90 percent of the planning area is underlain by breccia and basalt of the Clarno Formation and about 5 percent is underlain by Columbia River Basalts. Columbia River Basalts lie in the northeast corner of the planning area. According to the TEUI, basalt and andesite in the Clarno Formation tend to occur on and near ridge tops, with breccia elsewhere, perhaps because basalts weather more slowly. Basalt and andesite total about 45 percent of the planning area.

The Clarno formation includes flows of andesite and basalt, tuff, and volcanic mudflow breccias and conglomerates. Breccias and tuffs weather to clays. When wet, clay cannot support much weight, so slumps and landslides are common in Clarno terrain. Also, clayey soils have low infiltration rates. Basalt and andesite tend to weather to loam and clay loam, so they are not particularly prone to landslides or low infiltration rates.

Grassland soils are found throughout the planning area, particularly at lower elevations in the northern third. Grassland soils are technically called "Mollisols." Mollisols are characterized by thick, dark topsoil, resulting from the fact that many grasses and forbs put more organic matter belowground than trees do. So, why are there grassland soils, Mollisols, in forested areas? Probably because before fire suppression, these forested areas supported open, park-like stands, with abundant grasses and forbs between widely-spaced trees.

Detrimental Impacts

Table 2 shows existing detrimental conditions on all units in which existing detrimental conditions exceed 6 percent. Units with less than 7 percent would not need special project design criteria to meet the Forest Plan standard and were not included in the table. These units are a relatively small proportion of the units where commercial logging is planned. Existing detrimental conditions range from 0 to 13 percent. Most of the detrimental impacts are from compaction and associated puddling, and some displacement. In a few units, detrimentally burned soil occupies up to 2 percent of the area. Erosion (in forested areas) is negligible. Many units have recovered from previous logging, because decades have passed since previous logging in these units. Some units were never heavily impacted because they happened to be logged under winter or dry conditions.

Table 2. Existing condition, cumulative effects, and special project design criteria for all units with 7 percent or more existing detrimental conditions (percentages shown do not include roads).

Unit[1]	Existing detrimental impacts, percent of unit	Alternative 2 cumulative detrimental impacts, percent of unit	Special project design criteria[2]
30	7	17	-
94	10	16	b and d
95	10	16	b and d
148.2	13	16	b and s
148.3	9	16	b
166	8	16	b or d
180	7	16	-
204	7	16	-
242.2	9	17	b
254	12	16	b and w
264.2	10	16	b and d
274	7	17	-
286	9	17	b and d
346	7	17	-
348.2	10	17	b
386	10	17	b and d
388	7	16	-
396	7	16	b
400	8	16	b
414	13	16	b and s

[1] Decimal unit numbers, such as 264.2, denote subunits. See explanation in Methodology section.

[2] For a complete description, see the project design criteria in Table 3.

b = no biomass harvest except at the time of logging, or a more protective measure

d = dry soil, or a more protective measure

s = subsoiling, or a more protective measure

w = winter conditions or yarding with low ground pressure equipment riding on slash

Desired Condition

In compliance with Malheur Forest Plan standards, the area of detrimental soil impacts within each unit would not exceed 17 percent (20 percent minus 3 percent for roads). Detrimental soil conditions would be near the practical minimum.

Environmental Consequences

Methodology – Soil Quality

The project soils scientist has formed professional judgments on probable effects. Professional judgments are based on monitoring, personal observation (including observation in similar areas, and in this area), scientific literature, and professional contacts. These professional judgments are summarized in the "Quantitative logging effects on detrimental soil conditions" document in the project record. Briefly, effects are calculated based on existing condition, volume to be removed, biomass removal, the amount of draws, the amount of slopes steeper than 35 percent, the presence of a volcanic ash cap and coarse fragments, the amount of uphill skidding, and the presence of

short skid trails. However, quantitative effects cannot be precisely predicted. Soil science is not advanced enough to make precise predictions. In addition, effects of management depend on unknowns, such as weather, details of implementation, and whether a wildfire would occur.

Spatial and Temporal Context for Effects Analysis

The spatial context for effects analysis is each proposed unit. Unless otherwise noted the temporal context is after operations cease.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

Past and present activities relevant to soil cumulative effects analysis listed in the Camp Lick EA, Appendix E – Past, Present, and Reasonably Foreseeable Future Actions are timber harvest, roads, and fuel treatments. Soil assessments indicate that fire suppression, livestock grazing, off-highway vehicle use, firewood cutting, invasive plant treatments, and other past and ongoing activities have negligible effects on soil in proposed harvest units.

None of the foreseeable activities are likely to meaningfully impact soil.

Project Design Criteria and Mitigation Measures

Table 3. Project design criteria for soil quality

Criterion number	Objective	Design criterion	Responsible person
Soil-1	Minimize impacts and meet Malheur Forest Plan standard	Keep soil impacts, especially long-lasting impacts, as small as practicable (as determined by the line officer) and keep cumulative detrimental soil impacts to less than 20% of the area of each unit.	District ranger
Soil-2	Minimize impacts and erosion, and meet Malheur Forest Plan standard	Avoid downhill skidding or forwarding on slopes steeper than 35%, where feasible, using directional felling and tractor winching. There shall be no downhill skidding or forwarding on slopes steeper than 44% for more than 40 feet. Units that appear to contain an acre or more of slopes steeper than 45% include: 12, 20,22, 24, 36, 38,40, 60, 68, 78, 90, 94, 104, 114, 120, 152, 154, 166, 168, 184, 188, 196, 200, 204, 212, 214, 238, 240, 246, 252, 254, 262, 264, 266, 268, 270, 278, 284, 286, 296, 300, 304, 306, 308, 309, 316, 318, 326, 330, 332, 338, 342, 344, 346, 370, 374, 376, 378, 384, 410, 414, 416, 418, 421, 434, 460, 502, 602, 606, 608, and 618.	Sale layout and sale administrator
Soil-3	Minimize impacts and erosion, and meet Malheur Forest Plan standard	Avoid uphill skidding or forwarding for more than 40 feet on slopes steeper than 35%.	Sale layout and sale administrator
Soil-6	Minimize impacts and meet Malheur Forest Plan standard	Re-use existing landings where feasible and where they are away from shallow soil areas and ephemeral draws unless approved by a hydrologist, soil scientist, or fisheries biologist.	Sale administrator
Soil-7	Minimize impacts and meet	On areas where existing skid trails spaced 100-140 feet apart can be reused, reuse the old skid trails. Otherwise, space skid trails about 120 feet apart where practical, using existing skid trails	Sale administrator

Criterion number	Objective	Design criterion	Responsible person
	Malheur Forest Plan standard	where possible and appropriate. Skid trails should average less than 14 feet wide.	
Soil-8	Minimize impacts and meet Malheur Forest Plan standard	Skidders or forwarders shall not be allowed off trails unless the soil is snow covered or frozen or under other conditions approved by a soil scientist. Directional felling and/or winching shall be used when necessary. Low ground-pressure equipment (<8.5 pounds per square inch [PSI]) can be allowed off trails on dry, snow covered, or frozen soil. For soil design criteria, “dry” means July–September, or obviously dry in the top 6 inches in other months; “snow covered” means sufficient snow strength and depth to prevent compaction; and “frozen” means the soil is frozen in the top 4 inches.	Sale administrator
Soil-9	Minimize impacts and erosion, and meet Malheur Forest Plan standard	Skidding shall not be done on any unit under wet soil conditions, when ruts 6 inches or deeper would form on a continuous 50 feet or more of skid trails. This includes units with inclusions of moist soil, probably including parts of units 148, 184, 188, 190, 200, 212, 354, 384, 412, 414, 458, and others.	Sale administrator
Soil-11	Minimize impacts and erosion, and meet Malheur Forest Plan standard	For harvesting with low ground pressure harvesters and forwarders, the following design elements apply: • Forwarders shall have a maximum of 12.0 pounds/square inch ground pressure. • Forwarders should ride on top of a mat slash where feasible. • Forwarder trails shall be spaced a minimum of 50 feet apart, center to center. • The machinery shall not be operated when the soil is wet. (For forwarders “wet” means when ruts would be 3 inches or deeper on a continuous 50 feet or more of forwarder trails.) • The machinery shall not be operated on slopes steeper than 35%, except for distances less than 40 feet.	Sale administrator
Soil-12	Minimize impacts and meet Malheur Forest Plan standard	Slash shall not be dozer piled (except on landings), unless a soil scientist determines that Forest Plan soil quality standards would be met.	Sale administrator, soil scientist
Soil-13	Minimize impacts and meet Malheur Forest Plan standard	Grapple piling and mastication shall be done with low ground pressure (<8.5 psi) machinery on dry, frozen, or snow covered soil, and machinery shall stay on existing skid trails where feasible.	Sale administrator, fuels COR
Soil-14	Minimize impacts and meet Malheur Forest Plan standard	Slash piles shall not cover more than 5% of any unit, not including piles on landings.	Sale administrator
Soil-15	Control erosion and meet	The Malheur Forest Plan ground cover standard shall be met when prescribed burning is completed	Burn boss

Criterion number	Objective	Design criterion	Responsible person
	Malheur Forest Plan standard		
Soil-16	Meet Malheur Forest Plan standard	Unit 166 shall be logged either a) on dry soil, or b) design criterion soil-17.	Contracting and sale administrator
Soil-17	Meet Malheur Forest Plan standard	For the following units and also units listed in design criteria soil–18, soil–19, and soil-20, no heavy equipment shall be allowed for biomass harvest unless it is done within 1 year of the logging, and it is done with the same type of equipment (skidders or forwarders). Units 148.3*, 242.2*, 286, 348.2*, 396, and 400.	Contracting and sale administrator
Soil-18	Meet Malheur Forest Plan standard	In the following units, apply either a) logging on dry soil and design criterion soil-17, or b) design criterion soil-19 (where appropriate). Units 94, 95, 264.2*, and 386.	Contracting and sale administrator
Soil-19	Meet Malheur Forest Plan standard	In the following units, either a) the purchaser shall subsoil skid trails and landings and apply design criterion soil-17, or b) apply design criterion soil-20 (where appropriate). Units 148.2* and 414.	Contracting and sale administrator
Soil-20	Meet Malheur Forest Plan standard	In the following unit, apply design criterion soil-17 and either a) yard on dry soil with low ground-pressure equipment riding on top of as much slash as feasible, or b) yard on frozen or snow covered soil (if compatible with winter range). Unit 254.	Contracting and sale administrator

*A "decimal" unit number indicates that only part of the unit requires this PDC. A map is available from the project soil scientist.

Alternative 1 – No Action

Direct and Indirect Effects

The no action alternative would cause no detrimental soil effects. Existing detrimental impacts range from 0 to 13 percent of the area of the proposed units. Detrimental effects would slowly decrease over decades due to growing roots, burrowing animals (including arthropods), and freezing water.

Cumulative Effects

Because there are no direct or indirect effects, no cumulative effects would occur.

Alternative 2 – Proposed Action

Direct and Indirect Effects - Soil Quality

Several of the proposed actions (inner RHCA ecological riparian treatments, prescribed burning and unplanned ignitions, existing road maintenance, opening of closed roads, closure or decommissioning of roads, and interpretive sign installation) would have no impact to negligible detrimental impacts on soil. Commercial thinning and fuels control, with accompanying heavy machinery use and temporary road construction, are the main actions that would impact soil.

Roads

Temporary road construction and use would displace and compact some soil. Rehabilitation of temporary roads may include subsoiling. On subsoiled temporary road segments, most

productivity lost to compaction would be restored; perhaps 80 percent the area of the roads would be in a restored condition. Productivity lost to displacement and untreated compaction (including on un-subsoiled roads) would recover over the course of several decades due to natural processes.

Decommissioning of existing roads would have effects similar to rehabilitation of temporary roads. Road decommissioning would increase productivity on the former roads, especially on subsoiled and/or re-contoured segments.

Skidder Logging

Skidding on steep slopes often causes displacement. Water bar construction also often causes displacement. Skidding bares soil, decreases infiltration, and channels overland flow, and thus can accelerate erosion. More displacement, erosion, and probably compaction occurs on steep slopes than on flatter slopes. Uphill skidding is expected to have more impacts than downhill, due to the additional power and slippage of wheels with uphill skidding.

However, the experience of the project soil specialist indicates damage by logging using the design criteria is acceptable because only moderate amounts of displacement occur, and because of the small size of the area affected. Displacement and erosion from steep slope skidding would be limited, because slopes steeper than 35 percent occupy a relatively small proportion of most units and because the extensive ground cover in forests absorbs sediment. Design criteria, such as directional felling and winching would also help limit displacement and erosion. Usually erosion of skid trails decreases through 1 to 3 years, until it stops. Decreased productivity due to severe displacement and erosion can last for hundreds of years. Design criteria that effectively control displacement and erosion include a prohibition on skidding on highly erodible soil, a prohibition on skidding on steep slopes (greater than 45 percent downhill, greater than 35 percent uphill), limitations on skidding in draws, and water bar requirements.

Skidding would cause negligible sediment export from the units, despite sediment movement within units as described in the preceding paragraphs. Sediment is normally deposited less than 15 feet downslope from skid trails as the water is slowed by ground cover and percolates into the soil. This is true even on slopes up to 45 percent.

Much of the skid trail area would be compacted, and some of the soil tracked only once or twice would be compacted. Compaction usually lasts more than 20 years; some compaction lasts more than 50 years. Design criteria effective at limiting compaction include requiring skid trails to be widely spaced, reusing existing skid trails where appropriate, prohibiting skidding under wet conditions, and allowing only low ground pressure machinery off of skid trails. The design measures would keep compaction to a practical minimum and Malheur Forest Plan standards likely would be met in all units.

Landings are severely impacted. The design criterion that encourages re-use of appropriately located landings would keep these impacts to a minimum.

Some harvest would occur in areas with moister soil, such as RHCAs, aspen stands, and other moist areas in uplands. Moister soils are more susceptible to compaction and puddling. However, the design criteria: 1) that require harvest in RHCAs only on dry or frozen soils, and 2) that bans ruts deeper than 6 inches, would limit operations on wet soil.

Forwarder Logging and Biomass Harvest

Forwarder logging causes less impact than skidder logging, due to the lower ground pressure of forwarders. Forwarders also tend to travel over slash, spreading the weight over a larger area. Forwarder/harvester logging systems increase detrimental impacts by only about 5 percent, and forwarder logging usually does not require landings, so impacts are less than from skidder logging.

Biomass harvest includes harvest of smaller material than "normal logging," which is the harvest of logs larger than 7 to 9 inches diameter. The effect of biomass harvest in units without normal logging only adds about 3 percent to existing detrimental impacts, because it is usually done with forwarders, and the forwarders are not as heavily loaded as they would be with logs.

Effects of biomass harvest after logging depend on whether the logging systems for the normal logging and for the biomass harvest are the same. If they are the same, (and biomass harvest is done soon enough after the normal logging that skid trails can still be seen) biomass harvest would add only about 1 percent more detrimental impacts. If logging systems for the normal logging and for the biomass harvest are not the same, biomass harvest would add about 3 percent more detrimental impacts. The difference between 3 percent and 1 percent is due to the fact that with different logging systems, the biomass harvest would make new forwarder/skid trails, whereas with the same logging systems the biomass harvest would use the same forwarder/skid trails.

Subsoiling or Winter Logging

Subsoiling or winter logging may be used on units 148.2, 254, and 414 as described in project design criteria Soil-19 and Soil-20. Subsoiling would decrease detrimental impacts by about 60 percent, for the skidtrails and landings subsoiled.

On units where winter logging is used, the increase in detrimental impacts would be 30 percent of the increase expected under early summer conditions.

Skyline Logging

Skyline logging causes much less displacement, erosion, and compaction than tractor logging - detrimentally affecting about 1 to 2 percent of the area.

Yarding with Tops Attached and Prescribed Burning

These activities are not expected to change detrimental impacts from those expected otherwise.

Grapple Piling, Pile Burning, and Mastication

A project design criterion requires grapple piling and mastication machinery to have a low ground pressure, to operate on dry soil, and to operate on skid trails where possible. With these design criteria, the project soils specialist expects grapple piling or mastication would compact about 1 percent of each unit where it is used. Feller bunchers of similar ground pressure operating off skid trails compacted about 1.5 percent of a unit (McNeil 1996). This would be in addition to impacts caused by harvest.

Soil beneath grapple piles would be detrimentally burned, taking many years to recover. However, the project soil specialist has rarely observed detrimentally burned soil that occupied more than 2 percent of a unit.

Summary of Logging and Fuel Control on Soil Quality

Table 2 presents expected detrimental impacts for the units with more than 6 percent existing impacts. As shown by the difference between "existing detrimental" and "cumulative detrimental" columns in Table 2, increases in detrimental impacts would be 9 or 10 percent on units without special project design criteria. On units with special project design criteria, increases would range from 3 to 9 percent in the various units. If the unit happens to be harvested over deep snow or on deeply frozen soil, increase in compaction would be about 30 percent of the predicted amount.

Riparian and Upland Watershed Restoration Treatments

Impacts from these treatments would be smaller than impacts from upland logging and fuel control, because volume per acre moved would be less, because slopes greater than 35 percent would be avoided, and because ARBO II requires that soil disturbance be confined to the minimum area and erosion be minimized. Fence construction may compact as much as 0.1 percent of some units due to use of off highway vehicles.

Range Fence Construction

Fence construction may compact as much as 0.1 percent of some units due to use of off highway vehicles.

Cumulative Effects – Soil Quality

Detrimental impacts from the proposed operations (logging, subsoiling, fuels control) add to impacts of past and ongoing actions. Table 2 "existing detrimental" column reveals all impacts on proposed units from past and ongoing activities, including timber harvest, fuel treatments, fire suppression, livestock grazing, firewood cutting, and off-highway vehicles (OHVs). The past and ongoing impact from roads is accounted for by the decrease of the maximum allowable detrimental impacts from 20 percent to 17 percent. Table 2 "cumulative detrimental" column, shows what the expected condition would be for units in the table (these figures include impacts from temporary roads). Maximum cumulative detrimental impacts would be 17 percent. Thus the Forest Plan standard of 17 percent would be met in all units in all alternatives.

For Riparian and Upland Watershed Restoration Treatments, the smaller impacts (compared with upland logging and fuel control) indicate cumulative impacts from these treatments would meet the Forest Plan standard. In addition, ecological riparian treatments would primarily occur where upland thinning units are adjacent to RHCAs, and the Forest Plan standard would be met in the adjacent upland units without special design criteria, which indicates the standard would also be met in the RHCAs.

Livestock grazing and firewood cutting would continue to impact a negligible amount of soil in harvest units, as recovery from past use balances impacts from future use. The negligible detrimental impacts from OHV use would decrease even more with implementation of the Malheur Travel Management Plan. Stream and riparian restoration under the Aquatic Restoration EA and aspen restoration probably would not affect much if any soil in proposed harvest units, but if so, the soil project design criteria in the Aquatic Restoration EA, combined with those in the Camp Lick EA, would provide sufficient soil protection.

Compliance with Forest Plan and Other Relevant Laws, Regulations, and Policies

All alternatives would be consistent with Malheur Forest Plan soil protection standards, because design criteria would keep impacts small enough that cumulative effects from proposed activities would comply with the standards. Reasons are explained in the preceding sections of this report.

As explained in the Regulatory Framework section, compliance with the Malheur Forest Plan means that all alternatives meet all legal and regulatory requirements.

Soil Erosion: Water Quality and Soil Productivity

Affected Environment

Methodology

The best source of information about the location of soil types is the TEUI. However, some spots of highly erodible soils are too small to be mapped in the TEUI. Soil assessor technicians looked for highly erodible soil in the stands they visited.

Description of erosion is based on informal observations by the project soil scientist with over 25 years of experience on the Malheur National Forest.

Existing Condition

Forested soils have abundant ground cover, so the potential for erosion exists only where ground cover has been removed. The high infiltration rate of ash cap soils tends to reduce runoff, and thus erosion. However, if runoff does occur on ash cap soils, the soil particles are easily detached and eroded. The erosion hazard of forest soils is low on slopes less than 30 percent and moderate on slopes more than 30 percent.

Unconsolidated landslide deposits can be a source of sediment, but abundant vegetation supported by landslides and overlying volcanic ash helps control soil erosion. Landslides shown on the map in the project record comprise 3 percent of the planning area and are scattered throughout. Many of the landslides probably started during the ice ages, when there was abundant water and less vegetation. The landslides continue to slowly move downhill with shallow creep and slumps, often only several yards across. Existing roads on the large landslide have caused a few, small failures. If roads are built on landslides, care is needed to avoid causing more movement.

Sensitive soil types include un-forested, shallow, rocky soils supporting low amounts of ground cover, mainly in juniper woodlands or non-forested areas – "scab soils." Scab soils cannot absorb much water, and produce overland flow. These soils tend to be erodible, and generally are not found in timber harvest units but can be adjacent to units. “Scab soils” are generally more concentrated in the northern third of the planning area, but are scattered through most of the planning area.

Slopes steeper than 35 percent are widespread in the planning area, but are more concentrated along Camp Creek (between Coxie and Trail creeks), Trail Creek, Cougar Creek, West Fork Lick Creek, and Lick Creek.

Elevations range from about 3,500 feet, near the confluence of Camp Creek and the Middle Fork John Day River, to about 6,200 feet at Cougar Rock and Ragged Rocks. Precipitation ranges from about 16 to 28 inches per year, depending on elevation.

Desired Condition

Soil erosion from soil within units would not affect water quality or permanently impair productivity of non-forest areas.

Environmental Consequences - Soil Erosion

Methodology

Description of erosion is based on observations by the project soil scientist with over 25 years of experience on the Malheur National Forest.

Spatial and Temporal Context for Effects Analysis

The spatial context for effects analysis is each proposed unit, and flow paths that might connect it to a stream. Unless otherwise noted, the temporal context is directly after operations cease, when effects are maximum.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

Past and present activities relevant to soil cumulative effects analysis listed in the Camp Lick EA, Appendix E – Past, Present, and Reasonably Foreseeable Future Actions are timber harvest, roads, and fuel treatments. Soil assessments indicate fire suppression, livestock grazing, off-highway vehicle use, firewood cutting, invasive plant treatments, and other past and ongoing activities have negligible effects on soil in proposed harvest units.

None of the foreseeable activities are likely to meaningfully impact soil.

Project Design Criteria and Mitigation Measures

Table 4. Project design criteria for soil erosion (see also Table 3)

Criterion number	Objective	Design criterion	Responsible person
Soil-4	Control erosion	Draw bottoms are not appropriate for skidding or forwarding. If the only way to log a particular part of a unit is to skid in the draw bottom, that part of the unit shall be excluded from harvest. Units that appear to contain narrow draw bottoms include: 96, 116, 144, 152, 156, 188, 190, 200, 204, 238, 242, 246, 259, 262, 264. 270, 278, 304, 308, 330, 334, 346, 350, 398, 418, 460, and 502.	Sale layout and sale administrator
Soil-5	Control erosion	No heavy equipment shall be allowed on inclusions of highly erodible soil. “Inclusions of highly erodible soil” generally means areas larger than 50 feet diameter, and either 1) steeper than 30%, with less than 75% ground cover, 2) 20-30% slope with less than 50% ground cover, or 3) 10-19% slope with less than 25% ground cover. A Forest Service soils specialist can approve exceptions. Inclusions of highly erodible soil probably occur in parts of units 40, 140, 200, 264, 286, 308, 398, 412, and others.	Sale layout and sale administrator
Soil-10	Control erosion	Runoff and erosion from skid trails, skyline corridors, and tractor-winch furrows shall be controlled by the use of waterbars or comparable measures. Outfalls of the waterbars shall be clear and located on soil where water will infiltrate, not on shallow or	Sale administrator

Criterion number	Objective	Design criterion	Responsible person
		impermeable soil. Waterbars should be spaced appropriately for the terrain.	
Soil-21	Control erosion	For subsoiling, erosion shall be controlled by subsoiling in a “J” pattern, or installation of water bars, or comparable measures. If runoff cannot be diverted out of the furrows, such as in draw bottoms, subsoiling shall not occur. Skid trails on slopes steeper than 35% should not be subsoiled. Do not subsoil sections of skid trails where excessive rock would be pulled to the surface. Do not subsoil skid trails in RHCAs.	Sale administrator
Soil-22	Control erosion	During juniper encroachment treatments, heavy equipment shall not be used more than 10 feet off roads, except in stands with a commercial thinning or biomass prescription.	Non-commercial thinning contracting officer representative (COR)
Soil-23	Control erosion	Temporary roads in scabs shall not be steeper than 6%. They shall be constructed and used only when the soil is obviously dry to a depth of 10 inches or throughout the profile (whichever is less), or frozen, or protected by snow. After use, 4 inches of slash shall be placed at outfall of waterbars, and slash shall be scattered on the surface of the road. Exceptions can be approved in advance by a soil scientist or hydrologist.	Engineer, sale administrator

Alternative 1 – No Action

Direct and Indirect Effects

The no action alternative would cause no erosion. However, one consequence of the no action alternative is that the risk of a high severity wildfire would continue to increase (see the Fire, Fuels and Air Quality section of the Camp Lick EA), increasing the hazard of soil erosion.

Cumulative Effects

Because there are no direct or indirect effects, no cumulative effects would occur.

Alternative 2 – Proposed Action

Direct and Indirect Effects – Soil Erosion

Roads

During temporary road construction, use, and rehabilitation, and during road decommissioning soil may be eroded from the road surface. The sediment would be deposited within 20 feet of the edge of the road. Subsoiling would slightly increase the erosion risk for about 2 years.

Skidder Logging

Erosion from skidder logging is closely related to displacement, compaction, and puddling, as described in the "Soil Quality" section above.

Forwarder Logging and Biomass Harvest

As described in the "Soil Quality" section above, impacts from forwarder logging and biomass harvest is expected to be less than from skidder logging. In addition, the slash crushed in

forwarder trails provides ground cover and roughness that further control erosion. So erosion is expected to be less.

Subsoiling or Winter Logging

Subsoiling bares soil, forms channels, makes soil particles more easily detachable, and disrupts roots, thus raising the risk of erosion for a few years. However, subsoiling also increases infiltration which decreases the risk of erosion. This increased infiltration, and the subsoiling design criteria would control sediment production so it would be negligible.

Winter logging greatly decreases detrimental impacts, and so decreases the potential for erosion.

Skyline Logging

Logs that drag during skyline logging can displace soil and concentrate erosive runoff in furrows. Required cross drains would divert runoff from the furrows, so the amount of erosion would be negligible, and soil would be unlikely to leave the unit.

Yarding with Tops Attached, Grapple Piling and Pile Burning, and Mastication,

These activities are not expected to remove enough ground cover or cause enough rutting to change erosion.

Prescribed Burning

Soil effects from prescribed burning would be minor. Ground cover would decrease, especially during fall burns. However, burning would be controlled so as to avoid decreasing ground cover below forest plan standards (Forest-wide standard 127), so erosion would not be meaningful. The ground cover would recover between 1 and 5 years.

Soil effects from fire line construction would be minor. Erosion would be controlled by a design criterion that requires waterbars, and bans fire lines that go down draw bottoms. Fire lines impact a negligible area of soil.

Summary of Soil Erosion from Logging and Fuel Control

Even under the highest erosion scenario (skidder logging), sediment is not expected to leave any unit, so no adverse effects to water quality are expected from activities in units, and there would be no skidding on highly erodible soil, and thus no permanent impairment of land productivity, for any alternative. Soil erosion resulting from any alternative is negligible.

Riparian and Upland Watershed Restoration Treatments

Aspen Restoration, Ecological Riparian Treatments, and Large Woody Debris Treatments

Areas with these treatments are flatter and regain ground cover faster than uplands areas, so erosion would be less than from upland logging. Also, for the large woody debris treatments, ARBO II requires that soil disturbance be confined to the minimum area and erosion be minimized, further reducing erosion.

Headwaters Restoration Treatments

The logging and prescribed burning for these treatments would be done with the normal erosion control design criteria, so Forest Plan ground cover standards would be met and soil erosion would be controlled. The units comprise headwater catchments of 12 to 39 acres around the very upper ends of draws or streams. Debris flows might result from surface and subsurface water converging at the bottom of the hill slopes in draw bottoms that have been collecting sediment

since the last severe fire. This converging water could cause saturation and gullying. Little if any sediment is expected to be produced from soil outside draw bottoms.

Cumulative Effects – Soil Erosion

The amount of soil erosion from these proposals is negligible, so the cumulative effects of soil erosion is negligible.

Compliance with Forest Plan and Other Relevant Laws, Regulations, and Policies

All alternatives would be consistent with Malheur Forest Plan soil protection standards, because design criteria would keep impacts small enough that cumulative effects from proposed activities comply with the standards. Reasons are explained in the preceding sections of this report.

As explained in the Regulatory Framework section, compliance with the Malheur Forest Plan means that all alternatives meet all legal and regulatory requirements.

Organic Matter and Nutrients

Affected Environment

Methodology

Existing condition is inferred from the effects of processes that add and remove nutrients and organic matter from these sites.

Existing Condition

Fire usually decreases the amount of nutrients on the land by volatilization, and sometimes by wind and water erosion. (However, nutrients usually become more available to plants for a period lasting a year or more after fires.) Fire suppression has caused nutrients to accumulate. This accumulation comes from the atmosphere, from mineral weathering, and from nitrogen fixation (mostly by ceanothus). Organic matter (OM) and nutrients probably have accumulated above amounts present before fire suppression, although this accumulation has been partially offset by nutrient removals during past logging and fuel treatments.

Prior to fire suppression, forest canopies were less dense than they are now, so grasses and forbs were more abundant. Grasses and forbs put more OM and nutrients into roots in the topsoil, whereas trees put more OM and nutrients above the mineral soil in wood, foliage, and forest floor (litter and duff). Consequently, before fire suppression, more OM and nutrients remained protected from fire in the topsoil, whereas now OM and nutrients are more exposed.

Desired Condition

Nutrients and organic matter are at levels approximating what they were before fire suppression.

Environmental Consequences – Organic Matter and Nutrients

Methodology

Effects are inferred from processes that add and remove nutrients and organic matter from these sites.

Spatial and Temporal Context for Effects Analysis

The spatial context for effects analysis the proposed units. Unless otherwise noted, the temporal context is after operations cease.

Past, Present, and Foreseeable Activities Relevant to Cumulative Effects Analysis

Past and present activities relevant to nutrients and organic matter listed in the Camp Lick EA, Appendix E – Past, Present, and Reasonably Foreseeable Future Actions are timber harvest, fuel treatments, and wildfire suppression. None of the foreseeable activities are likely to meaningfully impact soil nutrients and organic matter in the units.

Alternative 1 – No Action

Direct and Indirect Effects

The no action alternative would cause no changes in the trends for forest floors and nutrients. Forest floors and nutrients have accumulated due to decades of fire suppression, and this trend would continue. However, one consequence of the no action alternative is that the risk of moderate and high severity wildfire would continue to increase. In addition, fire suppression has caused OM and nutrients to be more aboveground, exposed to fire. If a high severity wildfire were to occur, much organic matter and nutrients would be volatilized, possibly decreasing the amount of organic matter and nutrients below amounts present before fire suppression.

Cumulative Effects

Because there are no direct or indirect effects, no cumulative effects would occur.

Alternative 2 – Proposed Action

Direct and Indirect Effects - Organic Matter and Nutrients

Logging, especially yarding tops attached and biomass utilization, would remove nutrients and organic matter in logs and foliage, and pile burning and prescribed burning would remove nutrients and organic matter during burning. The removal, especially the removal of nitrogen, may decrease site productivity a few percent on some sites. However, on most sites, productivity is likely limited by water, not by nutrients or organic matter. Also, removal of nutrients would be limited because most nutrients on the site would remain in the soil, in the remaining forest floor, and in remaining trees. So removal by logging and fire is expected to have minimal effect.

Cumulative Effects – Organic Matter and Nutrients

Removing organic matter and nutrients by logging and fire would move many sites back toward their fertility status before fire suppression, because nutrient and organic matter loss in fires was common then. Under the proposed action, more organic matter and nutrients would be cycled through the mineral soil and less through the forest floor. Before fire suppression, little dead wood existed, because low severity fires burned it up. However, fires possibly left more nutrients on site than piling and burning of slash does. Because these high fire frequency ecosystems have persisted for thousands of years with low levels of forest floor and dead wood, these ecosystems are adapted to low levels of surface organic matter, so removal of the unnatural organic matter would have only a small adverse effect.

Compliance with Forest Plan and Other Relevant Laws, Regulations, and Policies

All alternatives would be consistent with Malheur Forest Plan soil protection standards, because design criteria would keep impacts small enough that cumulative effects from proposed activities comply with the standards. Reasons are explained in the preceding sections of this report.

As explained in the Regulatory Framework section, compliance with the Malheur Forest Plan means that the proposed action meets all legal and regulatory requirements.

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